

# Dr. William Gorgas and his war with the mosquito

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*Today, little is written about the origins of the Panama Canal, even though this 70-km-long shortcut linking the Atlantic and Pacific oceans is an engineering feat that has not been equalled in modern times. The canal, which provides a route that is 16 000 km shorter than a trip around Cape Horn, opened in 1914 and provided immense economic benefits. However, this engineering marvel, which marked the 75th anniversary of its completion last month, was possible only because of a physician-led war against malaria and yellow fever — during the first attempt to build it (by the French) more than 22 000 workers died, with yellow fever and malaria being the main causes. "This gloomy Godforsaken isthmus is a nightmare region", one writer noted. "It is a land where the flowers have no odor, the birds no song; where men are without honor and women without virtue." (Unknown author in Canal Zone records, in Zipperman HH: A medical history of the Panama Canal. Surg Gyn Ob 1973; 137:110). That didn't stop an American attempt to build the canal, though, and in 1914 the first ship sailed through it. Dr. William Gorgas and his public health campaign was one of the main reasons that trip was possible.*

**T**o rid a jungle of its malaria a man of unique qualities and qualifications was needed, and William Crawford Gorgas proved such a man. Born into a traditional southern family in Alabama in 1854, he had his own slave while

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a boy. His father was a general in the Confederate Army during the Civil War, which ended when William was 11, and as a young man Gorgas sought an appointment to West Point, the US military academy. He was turned down, primarily because of low grades.

Showing the determination that was to become his trademark, Gorgas took another approach. Entering medicine, he graduated from New York's Bellevue Hospital Medical College in 1879 and then joined the army's medical corps. His first 20 years of service passed uneventfully, with one exception: while stationed in Texas he contracted yellow fever. Although nearly fatal, that attack provided lifelong immunity and made him a logical candidate for service in the tropics.

His first experience in the treatment of tropical disease came in Cuba during the Spanish-American War. In that turn-of-the-century conflict, 13 American soldiers died from disease for every one felled by a Spanish bullet. After American troops occupied Havana, Gorgas was posted there in 1898 to take charge of sanitation. Both civilians and American soldiers suffered from a multiplicity of tropical diseases, the most deadly being yellow fever. Gorgas believed the illness was caused by environmental contamination and ordered the city cleaned up. In the spring of 1899, though, there was a fresh outbreak.

While in Havana, Gorgas became involved in the historic experiments of Major Walter Reed, which pointed to the mosquito as the vector involved in yellow fever transmission. For nearly 3 weeks, army volunteers slept in the pajamas of yellow fever victims on beds doused with vomit

and stool. Despite exposure to these fomites, none became ill. However, when their arms were laid bare to mosquitoes that had fed on the blood of the yellow fever victims, they too became infected. These unequivocal results prompted Gorgas to switch his tactics from street cleaning to control of the mosquito population.

Elimination of the disease by this method proved a Sisyphean task. Fortunately for Gorgas, the city was under military rule and that made it much easier to carry out his orders. He began by quarantining infected houses and killing mosquitoes in the immediate neighbourhood by burning insecticide. When this wasn't enough to control the disease, he decided to kill all mosquitoes within city limits.

Havana was the largest city in the West Indies and in 1899 boasted a population of 236 000. Gorgas began by dividing it into 20 districts. Clean-up squads cleared the ditches and oiled the streets while individuals were responsible for oiling or screening all water on their property, under penalty of a \$10 fine. (A thin coating of oil kills mosquito larvae.) Gorgas kept a high profile — he constantly prowled Havana's streets to ensure that his orders were being followed to the letter.

His efforts resulted in a sharp drop in the prevalence of both yellow fever and malaria. In 1896 Havana had 1300 deaths from yellow fever; in 1901 there were fewer than 20. There was a concomitant decrease in the malaria rate, from 909 per 1000 in 1899 to 19 per 1000 in 1908. The army rewarded Gorgas in 1903 by promoting him to the rank of colonel and making him an assistant surgeon general.

It was no surprise, then,

when Gorgas was called on to take similar action in Panama when the United States decided to build a canal there. In 1904, when he was transferred to the isthmus, he expressed his concerns: "I feel confident of being able to eliminate yellow fever by the same methods that were so successfully adopted in Havana. But malaria, in my opinion, is the disease on which the success of our sanitary measures at Panama will depend. If we can control malaria, I feel very little anxiety about other diseases. If we do not control malaria our mortality is going to be heavy." (Gorgas WC: Report on the Isthmian Canal. *Engineering Rec*, New York, May 1904)

Gorgas knew by then, through the work of Ronald Ross and others, that the two diseases were transmitted by different species of mosquitoes. Yellow fever was carried primarily by *Aedes aegypti* which, for the most part, was found in cities. Malaria was transmitted by *Anopheles*, which was more hardy and survived readily in the wilds.

Unfortunately for Gorgas, he had to fight more than mosquitoes while in Panama. In Havana he had been granted a great deal of autonomy, but in the canal zone his actions were restricted by ignorant and unsympathetic superiors who ridiculed the notion that a small insect could endanger human lives. One canal commissioner lectured him in kindly, paternalistic tones: "On the mosquito you are simply wild. All who agree with you are wild. Get the idea out of your head." (McCullough D: *The Path Between the Seas*. Simon and Schuster, New York, 1977: 423)

Work on the canal started in June 1904 and Gorgas's first priority was to improve living conditions in Panama City, which had a population of 20 000 people. There was no central water supply or sewage system and only an inadequate hospital system, left by the French. Gorgas laid pipes to a local lake whose water had been proven safe. He installed a sewage system and

introduced indoor toilets and was given responsibility for garbage disposal.

He also ensured that the local health department either buried or cremated the dead. At the time it was local practice to exhume a body 2 years after burial and rent the grave to someone else. Gorgas ended this and other unsanitary traditions.

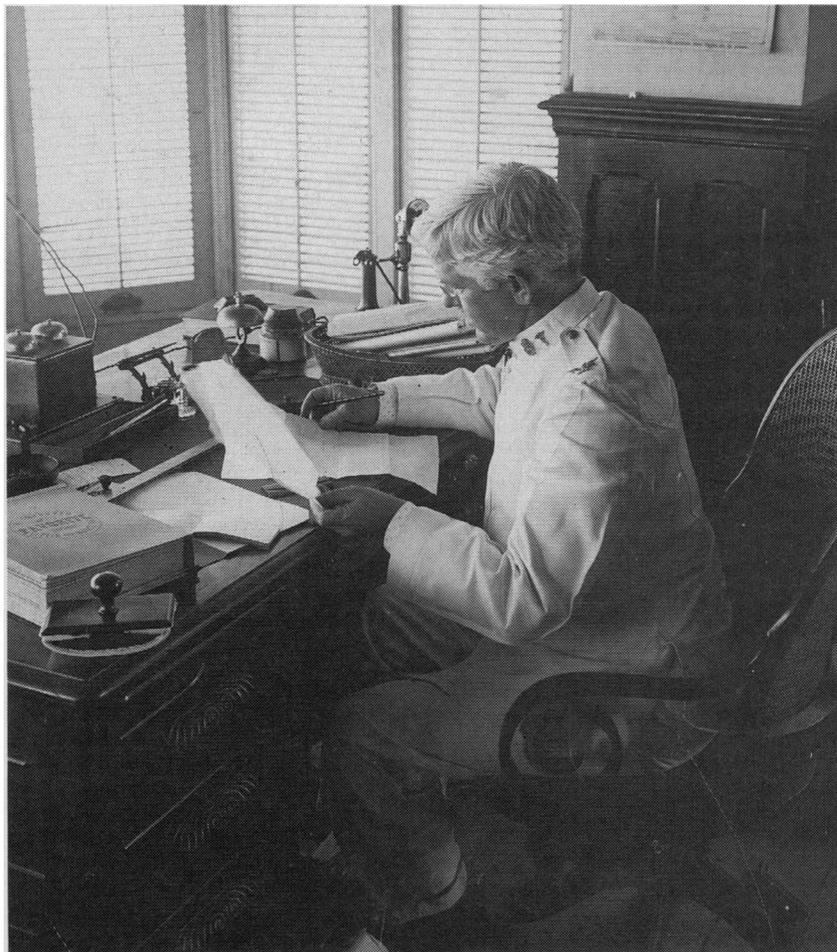
He began his fight against yellow fever by following the pattern established in Havana. He had every building in Panama City fumigated, thereby angering residents who suffered from the acrid fumes almost as much as the mosquitoes. (Ultimately, Gorgas proved one of the most popular US officers in Panama — he was one of the few who attempted to learn Spanish and understand local customs.)

Next he had his clean-up crews make a systematic sweep

through Panama City. They were followed by an outbreak of yellow fever. A second time Gorgas sent his gangs through the city and again the disease broke out behind them. These setbacks contributed to the scepticism of his detractors. Undeterred, Gorgas sent his crews through the city a third time, and on this attempt they proved successful; there were no further outbreaks. After 1906 the disease was non-existent in Panama, unless it arrived by ship. Such patients were quarantined to prevent any spread.

Although yellow fever was defeated, malaria continued to plague the isthmus. In 1906, the year yellow fever was eliminated, there were 1263 malaria-related hospital admissions per 1000 people. Workers suffered and the pace of construction slowed. If he was to eradicate malaria,

*The Bettmann Archive*



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Gorgas decided he would have to take the fight against mosquitoes to the jungle, the breeding ground of *Anopheles*.

Once again, he set about his work in systematic fashion. He increased his work force to 1200 men, organized into 25 sanitary districts. He provided protection for 80 000 workers and natives scattered among more than 30 villages and camps. As the canal progressed during the next 10 years, Gorgas had his crews clear the jungle of mosquito breeding grounds to a depth of up to 2 km on either side.

Sanitation crews employed a number of methods to eliminate the mosquitoes. They drained swamps where possible, or at least cleared the water of weeds, and burned insecticide and spread a mixture of carbolic acid, resin and caustic soda everywhere they went. This concoction was invented by Gorgas for use on the isthmus. Windows were either screened or workers were given netting for their beds. Some of Gorgas' men did nothing but kill mosquitoes by hand. A number of West Indians were hired to patrol the rail cars where the workers slept, armed with fly swatters and bottles of chloroform. A crude method, perhaps, but it proved surprisingly effective.

Once again, Gorgas was successful. With the elimination of mosquitoes from the construction sites, the rate of disease fell dramatically. In 1906 an estimated 800 of every 1000 workers suffered from malaria and 16 per 1000 died; by 1916 the figures were 40 and 9, respectively. Through the intervention of President Theodore Roosevelt, Gor-

gas was elevated from chief sanitary officer to membership on the Panama Canal Commission. He had won the battle against malaria in Panama because of his dogged refusal to quit in the face of adversity.

It is interesting to note that his campaign cost \$350 000 per year, or about \$3.50 per worker, at a time when a week's wages were little more. (Gorgas' salary at the time was \$14 000 per year.) The malaria-free zone was restricted to a narrow corridor bisecting the country, and to preserve that haven, strict military rule was required. Although it was effective at the time, his costly and time-consuming methods would not work on a large scale anywhere today. In the end, the victory against malaria in Panama was primarily a victory of superb administration. (Harrison G: *Mosquitos, Malaria and Man*, Dutton, New York, 1978: 165-167)

Gorgas' exploits did not go unrecognized. Sir William Osler noted: "There is nothing to match the work of Gorgas in the history of human achievement." (Russell PF, West LF, Manwell RD et al: *Practical Malariology*, Oxford U Pr, 1963: 16) Sir Malcolm Watson described his success as "the greatest sanitary achievement the world has ever seen". (Ibid: 17) Gorgas was more modest. In a 1914 letter to Ronald Ross, summing up what had transpired while building the canal, he wrote: "As you are aware, malaria was the great disease that incapacitated the working forces at Panama before our day. If we had known no more about the sanitation of malaria than the French did, I do not

think that we could have done any better than they did. Your discovery that the mosquito transferred the malaria parasite from man to man has enabled us at Panama to hold in check this disease, and to eradicate it entirely from most points on the isthmus where our forces were engaged. It seems to me not extreme, therefore, to say that it was your discovery of this fact that has enabled us to build the canal at the Isthmus of Panama." (Ross Archives, London School of Hygiene and Tropical Medicine, letter dated Mar. 23, 1914)

Gorgas' work did not stop with completion of the canal — he later served as president of the American Medical Association and surgeon general of the US Army. During the First World War he oversaw the expansion of the US Army Medical Corps from a few hundred officers to more than 30 000 men. In 1918 he retired at the compulsory age but continued to lead an active life, doing further work in tropical medicine in Ecuador, Guatemala and Peru.

While in London in 1920 Gorgas, then 66, had a stroke. On his deathbed he was knighted by King George V for "the great work which you have done for humanity". Funeral services were held at St. Paul's Cathedral and his remains were later buried in Arlington National Cemetery in Virginia. A research facility in Panama City was named in his honour.

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